

Transactions (*continued*).

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- Galton (Douglas, F.R.S.) An Address on the general principles which should be observed in the Construction of Hospitals. 8vo. *London* 1869. The Author.
- Palombo (E.) Della Proprietà e degli Ordinamenti Sociali, studi storico-economici. 8vo. *Napoli* 1869. The Author.
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The following communications were read:—

- I. “On the Mechanical Performance of Logical Inference.” By W. STANLEY JEVONS, M.A. (Lond.), Professor of Logic &c. in Owens College. Communicated by Professor E. ROSCOE. Received October 16, 1869.

(Abstract.)

It is remarkable that from the earliest times mechanical assistance has been employed in mathematical computation. The use of pebbles, of the

fingers, and of the *abacus* of the Greeks and Romans may be adduced as examples. Mathematicians have constantly delighted in devising mechanical modes of calculations, as in the case of Napier's bones, mechanical globes, slide rules, &c. Actual machines for performing difficult calculations have been designed or constructed at various times since the early part of the 17th century, by Pascal, Morland, Leibnitz, Gersten, Babbage, and Scheutz.

In logic, on the contrary, we meet with a total absence of any actual mechanism, although logical works abound with expressions implying the need of such aid. The name of Aristotle's logical treatises, the 'Organon,' or *Instrument*, and many definitions of logic, clearly express this idea, which is also distinctly stated by Bacon in the second aphorism of his 'New Organon.'

This inability of logicians to realize their notions of a mechanical logic in a material form, analogous to the many kinds of calculating machines, can only be explained by the extreme incompleteness of their doctrines. It is the advance of logical science, chiefly due to the late Dr. Boole, Prof. De Morgan, and George Bentham, which now enables us to produce a truly mechanical logic.

Boole, in his celebrated work on the 'Laws of Thought,' first put forth the problem of logical science in its complete generality :—*Given certain logical premises or conditions, to determine the description of any class of objects under those conditions.* The ancient forms of logical deductions are but a few isolated cases of this general problem, which Boole solved in a complete but exceedingly obscure manner. In my 'Pure Logic' (London, 1864, Stanford) and my 'Substitution of Similars' (London, 1869, Macmillan), I have endeavoured to show that the mysterious mathematical form of Boole's logical system is altogether superfluous, and that in one point of great importance he was deeply mistaken. His logical views, when simplified and corrected, give us a method of indirect deduction of extreme generality and power, founded directly upon this most fundamental Law of Thought. A proof of the truthfulness and power of this system is to be found in the fact that it can be embodied in a machine just as the Calculus of Differences is embodied in Mr. Babbage's calculating machine.

To explain the nature of the logical machine alluded to, it may be pointed out that the third of the fundamental Laws of Thought allow us to affirm of any object one or the other of two contradictory attributes, and that we are thus enabled to develope a series of alternatives which must contain the description of a given class or object. Thus, if we are considering the propositions—

Iron is metal,
Metal is element,

we can at once affirm of iron that it is included among the four alternatives :—

Metal, element,
 Metal, not element.
 Not metal, element.
 Not metal, not element.

But according to the second Law of Thought, nothing can combine contradictory attributes, and this law prevents us from supposing that *iron* can be *not metal*, while the first premise affirms that it is *metal*. The second premise again prevents our supposing that the combination *metal, not element* can exist. Hence the only combination of properties which the premises allow us to affirm of *iron* is *metal, element*. In a similar manner a complete solution of any logical problem may be effected by forming the complete list of combination, in which the terms of the problem can manifest themselves, and then striking out such of the combinations as cannot exist in consistency with the conditions of the problem.

The logical machine actually constructed represents the combination, 16 in number, of four positive terms, denoted by A, B, C, D, and their corresponding negatives, *a, b, c, d*. The instrument is provided with eight keys, representing these terms when appearing in the subject of a proposition, with eight keys, placed to the right hand of the former, representing the terms when occurring in the predicate of a proposition, and with the certain *operation* keys denoting the *copular* of the proposition, the *full stop* at the end of it, and the conjunction *or*, according as it occurs in the eulyceet or predicate. There is also a key denoting the *finis* or end of an argument, which has the effect of obliterating any previous impressions, and making the machine a *tabula nasa*. If, now, each of the letter terms A, B, C, D be taken to represent some logical term or noun, and propositions concerning them be, as it were, played upon the machine, as upon a telegraphic instrument, the machine effects thereby such a classification and selection of certain rods representing the 16 possible combinations of the terms, that only those combinations consistent with the propositions remain indicated by the machine at the end of the operations. When once a series of propositions is thus impressed upon the machine, it is capable of exhibiting an answer to any question which may be put to it concerning the possible combinations which form any class.

The machine thus embodies almost all the powers of Boole's logical system up to problems involving four distinct terms, and to represent problems of any complexity involving any number of terms only requires the multiplication of the parts of the machine. The construction involves no mechanical difficulties, and depends upon a peculiar arrangement of pins and levers, which it would not be easy to explain without drawings. In this arrangement of the parts the conditions of correct thinking are observed; the representative rods are just as numerous as the laws of thought require, and no rod represents inconsistent attributes. The representative rods are classified, selected, or rejected by the reading of a proposition in a manner exactly answering to that in which a reasoning

mind should treat its ideas, and at every step in the progress of a problem the machine indicates the proper condition of a mind exempt from mistake.

It is believed that this logical machine may be usefully employed in the logical class-room to exhibit the complete analysis of any argument or logical problem ; and it is superior for this purpose to a more rudimentary contrivance, the logical abacus, constructed by me for the same purpose and previously described. But by far the chief importance of the machine is in a theoretical point of view as demonstrating, in the simplest and most evident manner, the character and powers of a universal system of logical deduction, of which the first, although obscure solution, was given by Dr. Boole.

II. "Preliminary Paper on certain Drifting Motions of the Stars."

By RICHARD A. PROCTOR, B.A., F.R.A.S. Communicated by
WARREN DE LA RUE, V.P.R.S. Received October 26, 1869.

A careful examination of the proper motions of all the fixed stars in the catalogues published by Messrs. Main and Stone (*Memoirs of the Royal Astronomical Society*, vols. xxviii. and xxxiii.) has led me to a somewhat interesting result. I find that in parts of the heavens the stars exhibit a well-marked tendency to drift in a definite direction. In the catalogues of proper motions, owing to the way in which the stars are arranged, this tendency is masked ; but when the proper motions are indicated in maps, by affixing to each star a small arrow whose length and direction indicate the magnitude and direction of the star's proper motion, the star-drift (as the phenomenon may be termed) becomes very evident.

It is worthy of notice that Mädler, having been led by certain considerations to examine the neighbourhood of the Pleiades for traces of a community of proper motion, founded on the drift he actually found in Taurus his well-known theory that Alcyone (the *lucida* of the Pleiades) is the common centre around which the sidereal system is moving. But in reality the community of motion in Taurus is only a single instance, and not the most striking that might be pointed out, of a characteristic which may be recognized in many regions of the heavens. In Gemini and Cancer there is a much more striking drift towards the south-east, the drift in Taurus being towards the south-west. In the constellation Leo there is also a well-marked drift, in this case towards Cancer.

These particular instances of star-drift are not the less remarkable, that they (the stars) are drifting almost exactly in the direction due to the proper motion which has been assigned to the sun, because the recent researches of the Astronomer Royal have abundantly proved that the apparent proper motions of the stars are not to be recognized as principally due to the sun's motion. Mr. Stone has shown even that we must assign to the stars a larger proper motion, on the average, than that which the sun possesses.